

CLAIMS

We claim:

1. A method for transferring information from a device coupled
2 to a bus over a network, the method comprising:
 - 3 capturing the one or more bus events corresponding to a split
4 transaction generated by a bus device and sending an indication or response
5 to the device that the transaction has been completed using a network
6 interface;
 - 7 encapsulating the captured bus events into packets associated with a
8 network protocol using the network interface after sending the indication or
9 response; and
 - 10 sending the packets over the network to a remote site, where the one
11 or more bus events encapsulated in the packets are decapsulated in order to
12 recreate the one or more bus events.

1. 2. The method defined in Claim 1 further comprising the bus
2 device immediately beginning another transaction in response to the
3 transaction complete indication or response.

1 3. The method defined in Claim 1 wherein the transaction
2 comprises an IEEE-1394 transaction.

1 4. The method defined in Claim 1 wherein the network interface
2 comprises a peripheral server.

1 5. The method defined in Claim 1 further comprising hardware
2 in the network interface posting the transaction into a memory and
3 generating the indication or response prior to transmitting the packets over
4 the network.

1 6. A system comprising:
2 a network;
3 a bus;
4 a bus device coupled to the bus, wherein the bus generates a split
5 transaction on the bus as one or more bus events;
6 an interface coupling the network to the bus, the interface tunneling
7 bus events over the network from the bus device by capturing the bus
8 events, sending an indication or response to the bus device that the
9 transaction has been completed, and then encapsulating bus events

10 generated by the bus device into packets and transferring the packets over
11 the network.

1 7. The method defined in Claim 6 further comprising the bus
2 device immediately beginning another transaction in response to the
3 transaction complete indication or response.

1 8. The system defined in Claim 6 wherein the transaction
2 comprises an IEEE-1394 transaction.

1 9. The system defined in Claim 6 wherein the network interface
2 comprises a peripheral server.

1 10. The system defined in Claim 6 further comprising hardware in
2 the interface posting the transaction into a memory and generating the
3 indication or response prior to transmitting the packets over the network.

1 11. A method of transferring information between a device on a
2 bus to a destination comprising:
3 an interface receiving a write request generated by a serial bus device;

posting the write request on the interface by completing a split transaction immediately via a response generated by software and not placing the split transaction over the network and then sending the write request over the network;

the interface receiving an acknowledged completion indication from the serial bus device to inform the interface that the write response was received;

the interface encapsulating the serial bus write request into one or more packets with the tunneling header;

transmitting the one or more packets over the network; and

receiving a response that write request data has been delivered to a network host.

12. The method defined in Claim 11 wherein the response is a write response.

13. An apparatus for transferring information between a device on a bus to a destination comprising:

means for receiving a write request from the device and posting the write request on the interface unit by completing a split transaction immediately via a response generated by software and not placing the split

6 transaction over the network and then sending the write request over the
7 network;

8 means for receiving an acknowledged completion indication from the
9 device to inform the interface that the write response was received;

10 means for encapsulating the serial bus write request into one or more
11 packets with the tunneling header;

12 means for transmitting the one or more packets over the network; and
13 means for receiving a response that write request data has been
14 delivered to a network host.

1 14. The apparatus defined in Claim 13 wherein the response is a
2 write response.

1 15. An article of manufacture comprising a storage medium
2 having a plurality of executable instructions, which, when executed by a
3 processing device, cause at least one processing device to transfer
4 information between a device on a bus to a destination by:
5 receiving a write request from the device;
6 posting the write request on the interface by completing a split
7 transaction immediately via a response generated by software and not

8 placing the split transaction over the network and then sending the write
9 request over the network;

10 sending an acknowledged completion indication to inform that the
11 write response was received;

12 encapsulating the serial bus write request into one or more packets
13 with the tunneling header;

14 transmitting the one or more packets over the network; and

15 receiving a response that write request data has been delivered to a
16 network host.

1 16. The method defined in Claim 15 wherein the response is a
2 write response.

1 17. A method of transferring information between a device on a
2 bus to a destination comprising:

3 an interface receiving a write request from a serial bus device;

4 the interface generating an acknowledge complete indication to
5 indicate to the serial bus device that the transaction is complete;

6 the interface encapsulating the serial bus write request into one or
7 more packets, and with a tunneling header;

8 transmitting the one or more packets over the network; and
9 receiving a response that write request data has been delivered to a
10 network host.

1 18. The method defined in Claim 17 wherein the serial bus device
2 comprises a IEEE 1394 device.

1 19. The method defined in Claim 17 wherein hardware in the
2 interface generates the acknowledge complete indication immediately upon
3 receiving the write request.

1 20. The method defined in Claim 17 wherein the acknowledge
2 complete indication comprises an IEEE 1394 indication.

1 21. The method defined in Claim 17 wherein the serial bus device
2 sends a new write request as soon as the serial bus device receives the
3 acknowledge compete indication from the interface.

1 22. The method defined in Claim 17 wherein the interface
2 comprises remote peripheral server.

1 23. An apparatus for transferring information between a device on
2 a bus to a destination comprising:
3 means for receiving a write request from the device;
4 means for generating an acknowledge complete indication to indicate
5 to the serial bus device that the transaction is complete;
6 means for encapsulating the serial bus write request into one or more
7 packets, and with a tunneling header;
8 means for transmitting the one or more packets over the network; and
9 means for receiving a response that write request data has been
10 delivered to a network host.

1 24. The apparatus defined in Claim 23 wherein the means for
2 generating the write request comprises an IEEE 1394 device.

1 25. The apparatus defined in Claim 23 wherein the acknowledge
2 complete indication comprises an IEEE 1394 indication.

1 26. The apparatus defined in Claim 23 wherein the means for
2 generating the write request sends a new write request as soon as it receives

3 the acknowledge complete indication from the means for generating the
4 write response.

1 27. The apparatus defined in Claim 23 wherein the means for
2 generating the acknowledge complete indication and the means for
3 encapsulating the serial bus write request into a packet with the tunneling
4 header and transmitting the packet over the network comprise a remote
5 peripheral server.

1 28. An article of manufacture comprising a storage medium

2 having a plurality of executable instructions, which, when executed by a

3 processing device, cause at least one processing device to transfer

4 information between a device on a bus to a destination by:

5 receiving a write request from the device;

6 generating an acknowledge complete indication to indicate to the

7 serial bus device that the transaction is complete;

8 encapsulating the serial bus write request into a packets, and with a

9 tunneling header;

10 transmitting the one or more packets over the network; and

11 receiving a response that write request data has been delivered to a

12 network host.

1 29. A method of transferring information between a device on a
2 bus to a destination comprising:
3 an interface receiving a write request from a serial bus device;
4 the interface generating an acknowledge pending indication to
5 indicate to the serial bus device that the transaction is pending and awaiting
6 confirmation;
7 the interface immediately sending a serial bus write response to the
8 serial bus device indicating that the transaction has been completed;
9 the interface receiving an acknowledge completion indication from
10 the serial bus device informing the interface that the write response was
11 received;
12 the interface encapsulating the serial bus write request into a packet
13 with the tunneling header;
14 transmitting the packet over the network; and
15 receiving a response write request data has been delivered to a
16 network host.

1 30. The method defined in Claim 29 wherein the serial bus device
2 comprises an IEEE 1394 device.

1 31. The method defined in Claim 29 wherein the hardware in the
2 interface generates the acknowledge pending indication immediately upon
3 receiving the write request.

1 32. The method defined in Claim 29 wherein software in the
2 interface sends the write response.

1 33. The method defined in Claim 29 wherein the write response
2 comprises an IEEE 1394 write response.

1 34. The method defined in Claim 29 wherein the serial bus device
2 sends a new write request as soon as the serial bus device receives the write
3 response from the interface.

1 35. The method defined in Claim 34 wherein the interface
2 comprises a remote peripheral server.

1 36. An apparatus for transferring information between a device on
2 a bus to a destination comprising:

3 means for receiving a write request from a serial bus device and
4 generating an acknowledge pending indication to indicate to the serial bus
5 device that the transaction is pending and awaiting confirmation;

6 means for immediately sending a serial bus write response to the
7 serial bus device indicating that the transaction has been completed;

8 means for receiving an acknowledge completion indication from the
9 serial bus device informing that the write response was received;

10 means for encapsulating the serial bus write request into a packet
11 with the tunneling header and transmitting the packet over the network; and

12 means for receiving a response write request data has been delivered
13 to a network host.

1 37. The apparatus defined in Claim 36 wherein the means for
2 generating the write request comprises an IEEE 1394 device.

1 38. The apparatus defined in Claim 36 wherein the write response
2 comprises an IEEE 1394 write response.

1 39. The apparatus defined in Claim 36 wherein the serial bus
2 device sends a new write request as soon as it receives the write response
3 from the means for generating the write response.

1 40. The apparatus defined in Claim 36 wherein the means for
2 generating the write response and the means for encapsulating the serial bus
3 write request into a packet with the tunneling header and transmitting the
4 packet over the network comprise a remote peripheral server.

1 41. An article of manufacture comprising a storage medium
2 having a plurality of executable instructions, which, when executed by a
3 processing device, cause at least one processing device to transfer
4 information between a device on a bus to a destination by:
5 receiving a write request from a serial bus device;
6 generating an acknowledge pending indication to indicate to the
7 serial bus device that the transaction is pending and awaiting confirmation;
8 immediately sending a serial bus write response to the serial bus
9 device indicating that the transaction has been completed;
10 receiving an acknowledge completion indication from the serial bus
11 device informing the interface that the write response was received;

65 66 67 68 69 70

12 encapsulating the serial bus write request into a packet with the
13 tunneling header;

transmitting the packet over the network; and

15 receiving a response write request data has been delivered to a
16 network host.

1 42 A system comprising:

2 a network;

3 a bus;

4 a bus device coupled to the bus;

5 an interface coupling the network to the bus, the interface tunneling

6 bus events over the network to and from the bus device by encapsulating

7 bus events generated by the bus device into packets and transferring the

⁸ encapsulated bus events over the network for subsequent decapsulation to

9 recreate the bus events, and further wherein the interface sends an

10 announcement packet over the network that encapsulates bus events

¹¹ corresponding to a bus reconfiguration process for the bus.

1 43. The system defined in Claim 42 where the announcement

2 packet comprises a RAP packet.

1 44. The system defined in Claim 42 where the bus reconfiguration
2 process comprises an IEEE-1394 bus reconfiguration process.

1 45. The system defined in Claim 42 wherein the announcement
2 packet includes an information that a network host uses following the bus
3 reconfiguration process.

1 46. The system defined in Claim 42 wherein the interface
2 multicasts the announcement packet over the network.

1 47. The system defined in Claim 42 wherein the interface unicasts
2 the announcement packet to a server for access by other hosts.

1 48. A method of transferring information across a network
2 comprising:

3 capturing bus events corresponding to a bus configuration process
4 generated on a bus;
5 encapsulating the captured bus events into at least one packet
6 associated with a network protocol using an interface;

7 sending the at least one packet over the network so that the
8 capsulated bus event may be decapsulated to recreate the bus events at a
9 remote site.

1 49. The method defined in Claim 48 where the announcement
2 packet comprises a RAP packet.

1 50. The method defined in Claim 48 where the bus reconfiguration
2 process comprises an IEEE-1394 bus reconfiguration process.

1 51. The method defined in Claim 48 wherein the announcement
2 packet includes an information that a network host requires following the
3 bus reconfiguration process.

1 52. The method defined in Claim 48 wherein the interface multi-
2 casts the announcement packet over the network.

1 53. The method defined in Claim 48 wherein the interface unicasts
2 the announcement packet to a control server for access by other hosts.

1 54. An apparatus for transferring information across a network
2 comprising:
3 means for capturing bus events corresponding to a bus configuration
4 process generated on a bus;
5 means for encapsulating the captured bus events into at least one
6 packet associated with a network protocol using an interface;
7 means for sending the at least one packet over the network so that the
8 capsulated bus event may be decapsulated to recreate the bus events at a
9 remote site.

1 55. A system comprising:
2 a network;
3 a bus;
4 a Universal Serial Bus (USB) device coupled to the bus; and
5 an interface coupling the network to the bus, the interface tunneling
6 URB requests over the network to and from the bus device by encapsulating
7 the URB requests into network protocols and transferring the encapsulated
8 the URB requests over the network for subsequent decapsulation to recreate
9 USB bus events.

1 56. A method of transferring information across the network
2 comprising:
3 capturing bus events generated on a bus;
4 encapsulating URB requests that are based on the captured bus events
5 into packets associated with a network protocol using an interface; and
6 sending the encapsulated bus events for subsequent decapsulation at
7 a remote site.

1 57. The method defined in Claim 56 wherein the bus comprises a
2 USB bus.

1 58. A system comprising:
2 an asynchronous network;
3 a bus;
4 a bus device coupled to the bus, wherein the bus device generates
5 isochronous data;
6 an interface coupling the network to the bus, the interface tunneling
7 bus events over the network by encapsulating bus events into network
8 protocols, transferring the encapsulated bus events over the network, and
9 subsequently decapsulating the bus events to recreate the bus events, and

10 further wherein the interface buffers isochronous data to manage network
11 latencies.

1 59. The system defined in Claim 58 wherein the interface receives
2 a first packet to allocate resources.

1 60. The system defined in Claim 58 wherein the interface receives
2 a first packet to allocate network resources.

1 61. The system defined in Claim 58 wherein the interface receives
2 a first packet to allocate IEEE-1394 resources.

1 62. The system defined in Claim 58 wherein the interface receives
2 a first packet to allocate USB resources.

1 63. The system defined in Claim 59 wherein the first packet
2 specifies a maximum sized isochronous packet to be transmitted on the bus.

1 64. The system defined in Claim 59 wherein the first packet
2 specifies a tolerable latency for use in determining an amount of isochronous
3 data to buffer if necessary.

1 65. The system defined in Claim 59 wherein the interface sends a
2 second packet in response to the first packet to provide status of the resource
3 request.

1 66. A method of transferring information across the network
2 comprising:
3 capturing bus events;
4 encapsulating the captured bus events into packets associated with a
5 network protocol; and
6 an interface decapsulating the encapsulated bus event and recreating
7 them at a remote site, including buffering isochronous data to manage
8 network latencies.

1 67. A method of transferring information across a network
2 comprising:
3 a network host encapsulating bus events representing isochronous
4 data into packets associated with a network protocol;
5 sending the packets over the network;
6 decapsulating the encapsulated bus events and recreating them at a
7 remote site using an interface;

8 the interface sending a data confirmation packet over the network
9 after transmission of the bus events on a bus coupled to the interface; and
10 the network host processing the data confirmation packet and
11 determining whether to continue sending isochronous data.

1 68. A system comprising:
2 a network having a host coupled thereto, the host executing software
3 to generate packets for communication on the network;
4 a bus with a bus device coupled thereto;
5 an interface coupling the network to the bus, the interface and host
6 coordinating to tunnel bus events over the network between the host and the
7 bus device by encapsulating bus events into network protocols, transferring
8 the encapsulated bus events over the network, and subsequently
9 decapsulating the bus events to recreate the bus events, wherein the
10 interface sends a data confirmation packet to the host after transmission on
11 the bus of bus events representing isochronous data tunneled over the
12 network from the host, the host receiving the data confirmation packet and,
13 based on its contents, determines whether to continue sending isochronous
14 data.

1 69. A method of controlling devices across the network
2 comprising:
3 capturing bus events;
4 encapsulating the captured bus events into packets associated with a
5 network protocol, where at least one of the packets comprises an ownership
6 tunneling packet to manage network ownership of a bus device;
7 sending the packets on the network;
8 decapsulating the encapsulated bus event and recreating them at a
9 remote site.

1 70. The method defined in Claim 69 further comprising sending
2 the ownership tunneling packet to query current ownership of the bus
3 device.

1 71. The method defined in Claim 69 further comprising sending
2 the ownership tunneling packet to request ownership of the bus device.

1 72. The method defined in Claim 69 further comprising sending
2 the ownership tunneling packet to release ownership of the bus device.

1 73. The method defined in Claim 69 wherein the bus device
2 comprises an IEEE-1394 device.

1 74. The method defined in Claim 69 wherein the bus device
2 comprise a USB device.

1 75. An apparatus for controlling devices across the network
2 comprising:
3 means for capturing bus events generated on a bus;
4 means for encapsulating the captured bus events into packets
5 associated with a network protocol using an interface, where at least one of
6 the packets comprises an ownership tunneling packet to manage network
7 ownership of a bus device; and
8 means for decapsulating the capsulated bus event and recreating
9 them at a remote site.

1 76. The apparatus defined in Claim 75 wherein the bus device
2 comprises an IEEE-1394 device.

1 77. The apparatus defined in Claim 75 wherein the bus device
2 comprise a USB device.

1 78. The apparatus defined in Claim 75 wherein the ownership
2 tunneling packet queries current ownership of the bus device.

1 79. The apparatus defined in Claim 75 wherein the ownership
2 tunneling packet requests ownership of the bus device.

1 80. The apparatus defined in Claim 75 wherein the ownership
2 tunneling packet releases ownership of the bus device.